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Frequency Dependence of ATS-1 Observed
Micropulsations on Some Geophysical
Parameters

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Abstract

Frequency Dependence of ATS-1 Observed Micropulsations on Some Geophysical Parameters. Low frequency oscillations in the earth's magnetic field at the synchronous orbit have been observed with the UCLA magnetometer experiment on board the ATS-1 satellite since Dec. 1966. Some general characteristics of oscillations in the range $2 \times 10^{-3} < f < 20 \times 10^{-3}$ Hz have been previously reported by these authors. A further analysis of oscillations in the above mentioned range for the two year interval Dec. 1966 through Dec. 1968 is reported here. It was found that the frequency of an event increases with the sum of Kp for 24 hours prior to the event midpoint. For events with duration greater than 6 hours, the product moment correlation coefficient for frequency, f, and $\sum Kp$ was $R = 0.87$. The best least squares linear fit to the data for these events was $f = (0.32)\sum Kp + 5.1$. For the same events the correlation coefficient for frequency and Dst was $R = -0.83$.

In this paper we will discuss the correlation between the frequency of magnetic oscillations observed at ATS-1 and two indices of geomagnetic disturbance. The indices are $\sum Kp$ and $\langle Dst \rangle$. In tabulating $\sum Kp$ we summed the Kp index for 24 hours prior to the midpoint of the event as observed at ATS-1. In tabulating $\langle Dst \rangle$ for an event we also computed the average over 24 hours prior to the event midpoint.

We found that the frequency of oscillations is negatively correlated with $\langle Dst \rangle$, i.e., when $\langle Dst \rangle$ is large negative, the event frequency is high. We also found that the frequency of oscillations is well correlated with ΣKp, i.e., when ΣKp is high, the event frequency is also high. When the event frequencies are plotted against ΣKp, it appears that the oscillations can be divided into two groups; those that occur when the plasmapause is beyond the orbit of the satellite, and those that occur when the plasmapause is within the orbit of the satellite.

Slide 1. This slide shows equatorial Dst, taken from the compilation of Sugiura and Poras for the magnetic storm that began on September 20, 1967. On the same plot we have placed the low-frequency oscillations that occurred at ATS-1 during this storm. The occurrence of low-frequency oscillations is marked with a cross on this plot. The horizontal bar shows the duration of the event. The vertical bar is one standard deviation on either side of the average of the measured frequencies for the event. This plot further illustrates the tendency of an event frequency to be high during magnetically disturbed conditions and to decline as the magnetosphere grows progressively quieter during the recovery phase of the storm.

Slide 2. Noting the tendency illustrated in the previous slide, we decided to quantitatively compare the event frequency with $\langle Dst \rangle$ for 24 hours prior to the event midpoint. This slide represents the results of such a comparison. In this plot only those events with duration greater than or equal to 5 hours were selected. The ordinate of the plot gives the event frequency in milli-hertz and the abscissa gives the average value of $\langle Dst \rangle$ for 24 hours prior to a given event. The error bars give one standard deviation on either side of the average frequency of the event. The solid line is the least squares linear fit to the data. The product moment correlation coefficient for this data was -0.84. We then computed correlation coefficients for frequency and $\langle$Dst$\rangle$ over 12 hours.

Slide 3. In this plot we have included only those events that had duration greater than or equal to 6 hours. The absolute value of the correlation coefficient was -0.694. As events with shorter duration were included, we found that the correlation coefficient was reduced in absolute value from the value just mentioned.

Realizing that both Dst and Kp decrease together, we decided to quantatively compare the event frequencies with the sum of Kp for 24 hours prior to the event midpoint. The next slide shows the result of one such comparison.

Slide 4. The ordinate of the plot gives the event frequency in milli-hertz and the abscissa is the sum of Kp for 24 hours prior to the event midpoint. In this plot we have included those events greater than or equal to 6 hours. The error bars are of the same nature as those in previous slides. The correlation coefficient was 0.87.

Even though the linear fit to the data had a relatively high correlation coefficient, it appears that the oscillations occurred in two groups; this could be interpretated alternatively. One group occurs when ΣKp was approximately above 17. The next slide shows our interpretation of this result.

Slide 5. In this plot we have included all events with duration greater than or equal to 5 hours. We calculated linear fits and correlation coefficients for the two groups of data points. The linear fit for the points with Σ Kp $<$ 17 had an associated correlation coefficient 0.79. The correlation coefficient for the points with Σ Kp $>$ 17 was only 0.26, therefore the slope of this line is perhaps not very significant.

We suggest that the dividing line represents the plasmapause; i.e., when Σ Kp $<$ 17 (or average Kp $<$ 2) the plasmapause is beyond L = 6.5 on the day side of the magnetosphere, when Σ Kp $>$ 17 (or average Kp $>$ 2) the plasmapause is within L = 6.5. We believe this interpretation is consistent with direct satellite measurements of the plasmapause position (particularly the measurements reported by Taylor, Brinton, and Pharo).

In summary: We find that the frequency of magnetic oscillations observed at ATS-1 are well correlated with the two indices of geomagnetic disturbance, $\langle$ Dst $\rangle$ and Σ Kp. Also it appears that the Kp for 24 hours prior to the midpoint ordered the data in such a way that the events occurred in two distinct groups. For Σ Kp $<$ about 17 the oscillations occur at about 7 milli-Hz and for Σ Kp $>$ about 17 the oscillations occur at about 14 milli-hertz.

We believe that the lower frequency oscillation occur whenever the satellite is within the plasmapause and the higher frequency oscillation occur whenever the satellite is outside the plasmapause.

Acknowledgements

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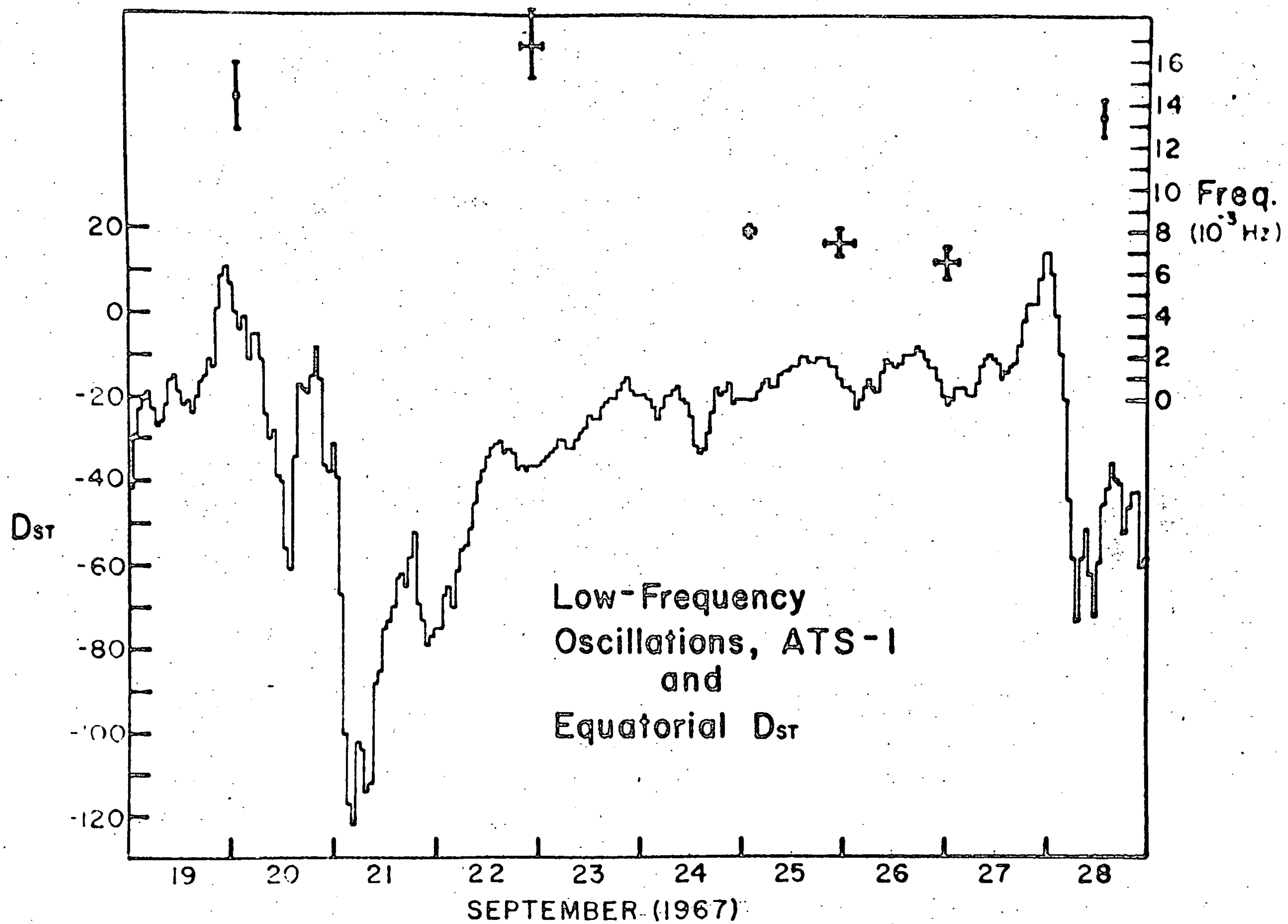
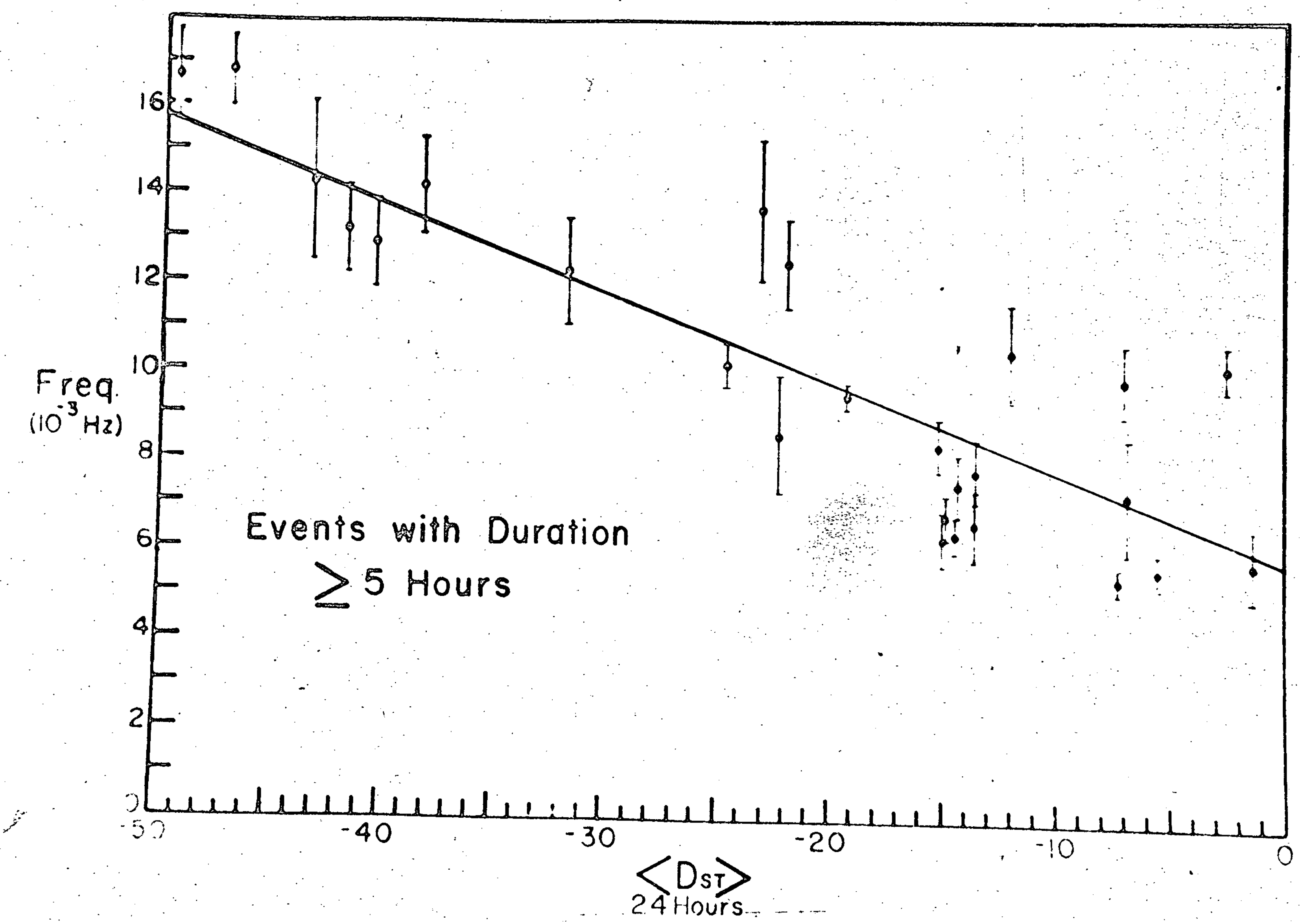
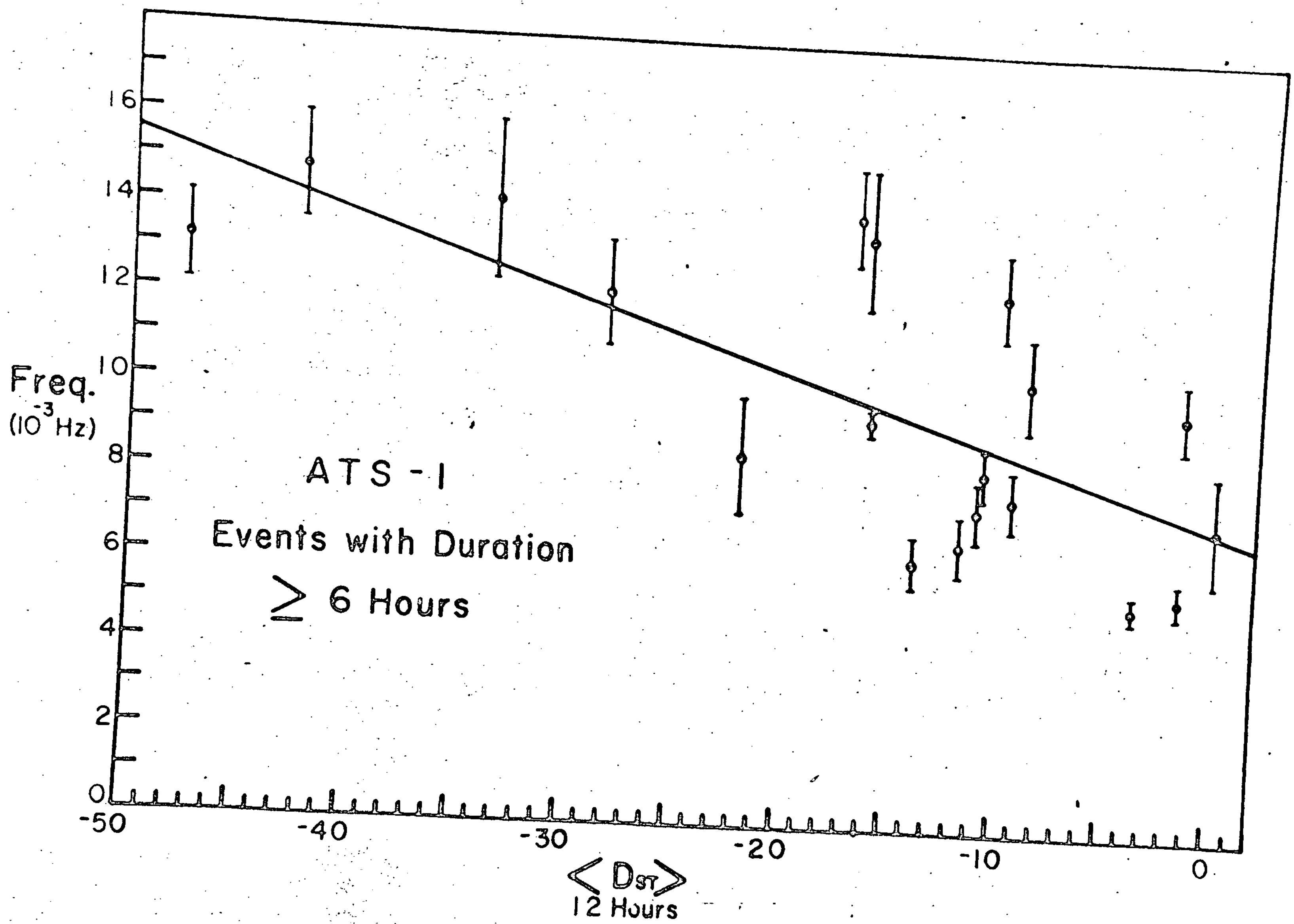

Low-Frequency
Oscillations, ATS-1
and
Equatorial D_{ST}
D_{ST}
Freq. (10^{-3} Hz)
SEPTEMBER (1967)

Slide 1

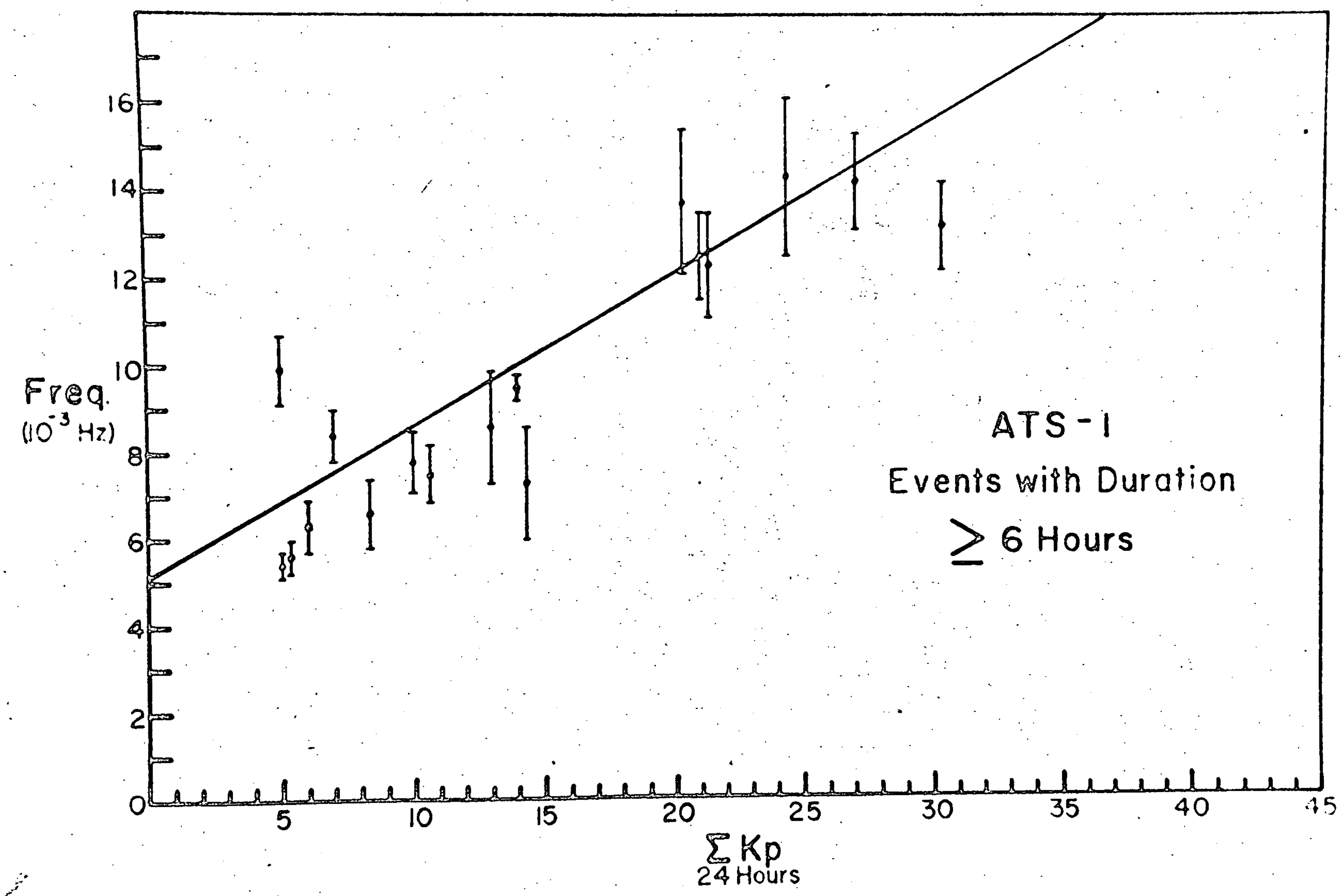

Freq.
(10^{-3} Hz)
16
14
12
10
8
6
4
2
0
-50
-40
-30
-20
-10
0
Events with Duration
≥ 5 Hours
$\langle D_{ST} \rangle_{24\ Hours}$

Slide 2

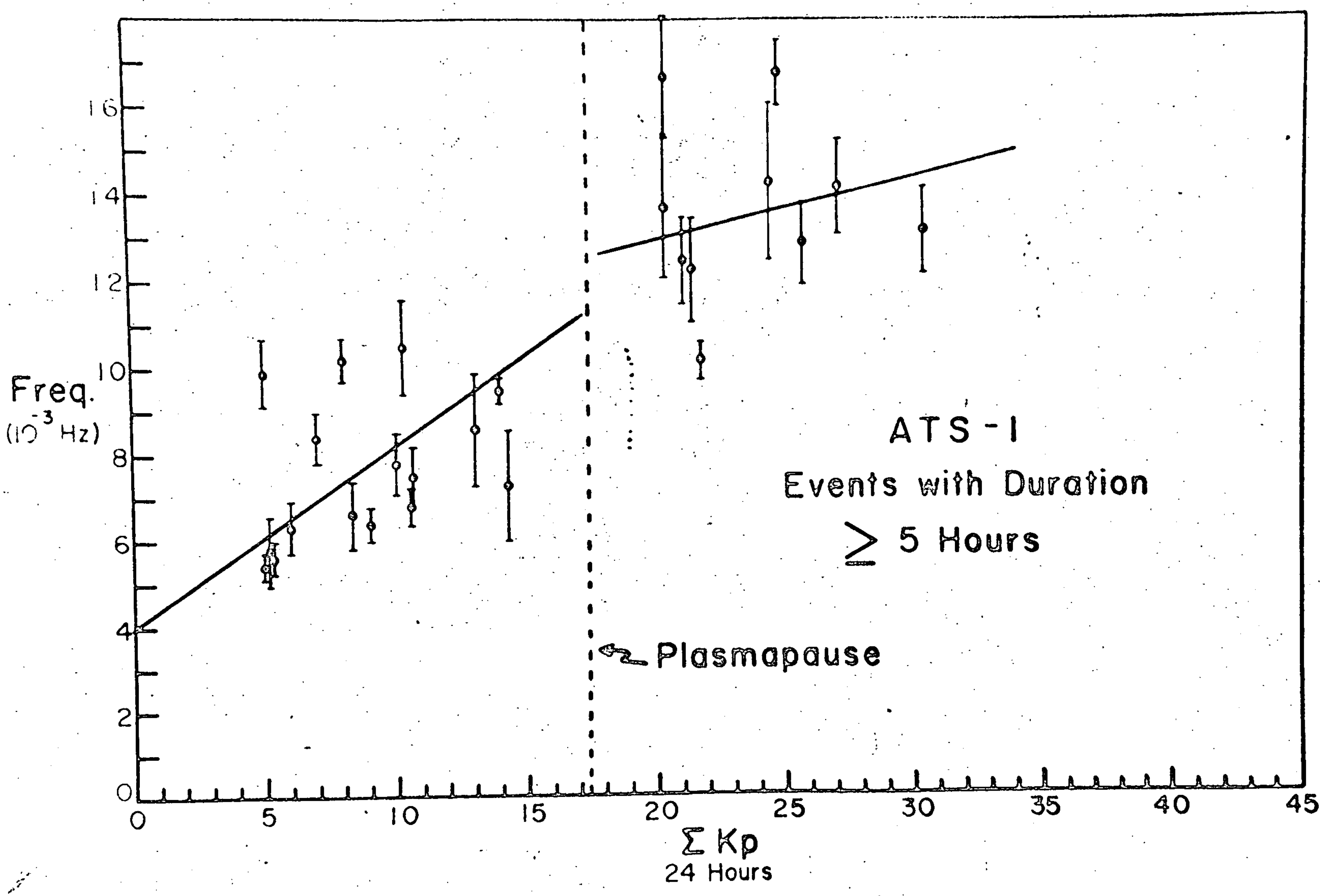


Freq.
(10^{-3} Hz)
16
14
12
10
8
6
4
2
0
ATS - I
Events with Duration
$\geq$ 6 Hours
-50
-40
-30
-20
-10
0
$\langle D_{ST} \rangle$
12 Hours

Slide 3


ATS - I
Events with Duration
≥ 6 Hours
Freq.
(10^{-3} Hz)
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
$\sum_{24\ \text{Hours}} Kp$

Slide 4


ATS - I
Events with Duration
≥ 5 Hours
Plasmapause
Freq. (10^{-3} Hz)
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30
35
40
45
Σ Kp
24 Hours

Slide 5